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Discounting Spotted Apples: Investigating Consumers' Willingness to Accept Cosmetic Damage in an Organic Product

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Discounting Spotted Apples: Investigating Consumers' Willingness to Accept Cosmetic Damage in an Organic Product

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The appearance of organic produce is often less than perfect because of limited methods of avoiding plant diseases. We combine hypothetical and real auction mechanisms to investigate how cosmetic damage affects consumers' willingness to pay for apples. We find that 75% of the participants are willing to pay more for organic than for conventional apples given identical appearance. However, at the first sight of any imperfection in the appearance of the organic apples, this segment is significantly reduced. Furthermore, the cosmetic damage has a larger impact on the willingness to pay for organic apples than for conventional apples.

Key Words: appearance, apples, experimental auctions, organic, willingness to pay

JEL Classifications: D12, Q13

Until recently, fresh food products such as apples were provided to markets as generic products. Today, such products are differentiated by brand, variety, origin, and appearance, as well as by the suppliers' production and processing methods. Consumers are often willing to pay large price premiums for products with the right attributes. As a result, product quality and differentiation have become increasingly important to producers.

Empirical estimates of price variation due to quality factors date back at least to Waugh's seminal 1928 study of quality factors affecting vegetable prices (Waugh). One of the most important quality factors is appearance. Appearance includes the intrinsic attributes of color, texture, size, uniformity, and other visible differences. Several recent studies consider how appearance affects consumers' preference for food products; see Acebron and Dopico for beef; Alfnes et al. for salmon; and Wei et al. for mandarin oranges. Consumers' search for food variety extends beyond the physical attributes to include credence attributes such as organic production method (Hobbs, Kerr, and Phillips). The credence attributes (Darby and Karni) are quality factors that consumers cannot identify through normal use of the product but that can be conveyed only through trust in the labeling. For fruits, organic production method is such a credence attribute, which is valued by consumers and becoming increasingly important in food markets.

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Many previous studies that investigate consumer preference for organic foods assume that the organic products are similar in appearance to their conventionally produced counterparts (e.g., Blend and van Ravenswaay; Boland and Schroeder). Loureiro and Hine studied consumers' willingness to pay (WTP) for local (*Colorado grown*), organic, and GMO-free potatoes. They found that the "*Colorado grown*" attribute afforded potato producers the highest consumer acceptance and premium compared with organic and GMO-free potatoes. For some organic products, such as organic processed foods, appearance of the original product is not a major concern (Larue et al.). However, most studies of unprocessed organic food products where, as expected, the appearance varies find that consumers discount products with cosmetic damage and value "good appearance" (Loureiro, McCluskey, and Mittlehammer).

Three studies find a positive effect from organic production (or nonuse of pesticides) and a negative effect of cosmetic damage. In a retail setting, Thompson and Kidwell found that the more cosmetic defects there were in organic produce, the less likely were shoppers to buy the organic produce. Experiment-based results from Roosen et al. showed that if cosmetic attributes were the same, consumers tended to pay a positive premium for nonuse of pesticides. However, if the nonuse of pesticides resulted in products with reduced cosmetic quality, fewer consumers preferred nonuse of pesticides. Baker conducted a survey involving consumer preferences for food safety attributes in fresh apples (specifically, reduced or no pesticide use) and took account of the damage level on red delicious apples using pictures.

Although the studies identify the role of appearance and organic production methods, less well understood is the nature of the trade-off—whether the measured response to cosmetic defects depends on the production method, and whether underlying consumer attitudes toward product and process attributes have an effect on the trade-off.

In this paper, we use a combination of a hypothetical and a real fourth-price sealed-bid auction to elicit consumer WTP for organic and conventional apples with different levels of blemish. The hypothetical auction, which uses pictures, has its strength in the internal validity of the experiment. Using the same pictures for both the organic and the conventional apples, we know that the differences in WTP that we find in this part of the study are due to the production method alone. The real auction has its strength in its external validity. With real economic incentives, the participants face a real trade-off between money and goods and, as in real markets, it is in consumers' own interest to act so that they maximize their own utility.

It is not the aim of this paper to compare the results of hypothetical and real auctions, and the two auction types used differ in both the presentation of the products (bags of apples versus pictures of apples) and in the nature of the auctions (real versus hypothetical). However, through combining the data from the real and hypothetical auctions, we utilize the strengths and alleviate the weaknesses of the two methods. The auction approach has been chosen because it allows us to elicit WTP differences and consumer attitudes in an experiment in which we control both the products and the participants. In contrast to real market data, the experiment permits us to elicit preferences for both ordinary products found in most grocery stores and for products rarely seen in grocery stores. Furthermore, it allows us to elicit attitudes toward organic products from all participants so that we can investigate how attitudes affect the WTP. Last, and in strong contrast to the market data, this approach allows us to elicit individual-level WTP differences among the various alternatives. For this to be possible we need WTP values for both the products that consumers prefer in the market and for the products they do not choose in the market. From market data we can observe only products the consumers chose; there is no way of knowing the value each consumer places on each of the products they did not choose.

In contrast to the consumer studies discussed earlier, we use an experimental design that allows not only the estimation of the main effects of production method and cosmetic damage but also the interaction effects between the two. Furthermore, the use of individual drawing

without replacement of the binding alternatives is new to the real auction mechanism included here. The latter allows us to combine the positive features of the incentive-compatible fourth-price auction with another feature important to a WTP study of products that are heterogeneous in so many ways, such as apples: the products the participants evaluated were the same products they would buy. The drawing of a single binding alternative ensured that there was never more than one buyer of each alternative. A similar approach of drawing a single binding alternative has been used previously in real choice experiments, for example, by Alfnes and colleagues.

A principal component factor analysis and a random parameter model are used in the analysis of how the WTP for apples is affected by (1) product attributes (conventional versus organic production methods, degree of blemish, and their interaction); (2) consumers' stated attitudes toward food safety, environmental aspects, use of pesticides, nutrition, prices, and appearance; and (3) consumers' sociodemographic characteristics. Specifically, we investigate the premium for organic apples, the discount for various levels of cosmetic damage, how cosmetic damage affects consumers' WTP for both organic and conventional apples, and how attitude and sociodemographic variables affect these premiums.

Market Experiment

The experiment had a within-subject design with two production methods (organic and conventional), four appearance levels (degrees of blemish), and two elicitation methods (hypothetical and real auctions). We also collected numerous sociodemographic and attitude measures. In addition, we tested three types of wordings in the instructions to the participants before the hypothetical auctions. The wording will be explored in a subsequent paper.

Products

The products used for this experiment were 3-lb bags of golden delicious apples. Apples were obtained from commercial sources and from university farm orchards. Prior to the experiment, the apples were sorted according to their production method and appearance. The production methods included both conventional and organic methods. For the appearance, the apples were then sorted by the level of surface blotches (cosmetic damage). The blotches were caused by plant diseases and syndromes, namely, sooty blotch fungi that led to changes that were strictly cosmetic and presented no harm to humans or to the taste of apples.

The apples were sorted into four categories, which we called SpotA, SpotB, SpotC, and SpotD. The SpotA apples were those without blotches; SpotB apples were those with about 3% blotch coverage; SpotC apples were those with about 5% blotch coverage; and SpotD were those with about 9% blotch coverage. The classification of apples was done with assistance from staff with training in plant pathology and experience in the marketing of local apples. All of the sorted apples were packed into clear bags. Where convenient, we refer to organic SpotA apples as OrganicA, and conventional SpotA apples as ConventionalA, and so on.

For the hypothetical auctions we took pictures of the apples. In order to avoid any reflection from the clear bags, the apples were removed from the bags before the pictures were taken. We took three pictures for each of the four categories (SpotA, SpotB, SpotC, and SpotD). As was the case for the real apples, the apples in the pictures were 3 lbs. and sorted by appearance. The participants were informed about the weight of the apples presented in the pictures.

In the real auctions, 12 bags[1] of apples were placed on a large table for visual inspection. The apples were labeled as organic or conventional but were not labeled with the appearance grade. Instead, participants examined the appearance of the apples and made bids based on their own observations. This was done to resemble a typical retail situation, in which the labels inform the consumers about the production method but do not convey anything about the appearance. Each alternative in the experiment had one specific bag of apples, and several of the

[1] The number 12 was set so that the there were more products than participants in each session.

alternatives had the same characteristics with respect to production method and cosmetic damage. Except for the spots and production method, each bag contained apples that were as homogeneous as possible in other characteristics, such as number, size, and weight.

Experimental Procedure

We conducted eight sessions with a total of 74 participants. The sessions included both hypothetical and real fourth-price sealed-bid auctions. In each of the auctions there was simultaneous bidding on 12 alternatives. A (real) fourth-price sealed-bid auction is an auction in which the bidders submit sealed bids and the price is set equal to the fourth-highest bid; the winners are those who have bid more than the price. Vickrey showed that in such an auction in which the price equals the first-rejected bid and each consumer is allowed to buy only one unit, it is a weakly dominant strategy for people to bid so that if the price equals their bid, they are indifferent to whether they receive the product or not. As a consequence, it is a weakly dominant strategy for people to truthfully reveal their private preferences. If they bid lower than their WTP they risk forgoing a profitable purchase. If they bid higher, they risk buying a product at a price that is above what they perceive the product to be worth given the available alternatives.

A direct consequence of Vickrey's result is that rational consumers would demand a payoff from the auction similar to that received when they buy their preferred alternative in the market. Hence, they would not bid above the market price for products sold in the market. Furthermore, for products not sold in the market, rational consumers would demand a payoff similar to that received when they buy their preferred alternative in the market. The net value of the alternative transaction, buying the type of apples with the highest net value in the market, is the same for all alternatives. As a consequence, all bids are reduced by the same amount, and the differences in bids represent the differences in value to consumers. For a theoretical discussion of this, see Alfnes, and for experimental support, see Corrigan and Rousu.

In the last 15 years, experimental auctions have been used to elicit WTP for a wide variety of food quality attributes (e.g., Hobbs et al.; Brown, Cranfield, and Henson; Alfnes and Rickertsen; Lusk, Feldkamp, and Schroeder; Lusk et al.; Melton et al.; Roosen et al.; Rozan, Stenger, and Willinger; Umberger and Feuz).

Recently, several studies have used a uniform *n*th price auction with single unit buyers such as ours to elicit WTP for food quality characteristics. See, for example, Umberger and Feuz for an application of a fourth-price sealed-bid auction, and Lusk et al. for an application of a fifth-price sealed-bid auction. Compared with the frequently used second-price auction, the fourth-price and other uniform *n*th price auctions have several benefits. First, if there are multiple winners, a winning position does not lead to an exclusive winner, and any utility the participant might gain from winning itself is reduced. Second, in a fourth-price auction with seven or more participants, there is a smaller difference between the median participant's valuation of the product and the price. Therefore, a bid that differs from a participant's WTP is more likely to have real economic consequences. Third, with repeated trials, extreme outliers are less likely to affect the price information that the participants receive during the multitrial experiments (Alfnes, Rickertsen, and Ueland).

After the real auction, each participant randomly drew his or her exclusive binding alternative. The drawing was done without replacement; only one participant could draw each of the alternatives as his or her binding alternative. For this to be possible, the number of alternatives had to be higher than or equal to the number of participants in each session. The price of an alternative was equal to the fourth-highest bid for that alternative. If the participants had bid more than the price for their binding alternative, they had to buy the alternative. This winning restriction allowed us to combine the attractive features of the uniform-price auction (discussed earlier) with another feature that we felt was imperative in a WTP study on appearance of a heterogeneous product such as apples: the products they evaluated

were the same products they would buy at the end of the auction.

At the beginning of each session, the participants were given a folder containing US$20, a consent document, and a questionnaire. There were a total of eight sessions. In six of the eight sessions, we first conducted a hypothetical auction in which the apples were represented by pictures. We asked participants to carefully examine the apples in the pictures before they made their hypothetical bids. After the hypothetical auctions, we replaced the pictures with actual apples and ran one trial with a real auction. In the last two sessions, we ran two trials with real auctions instead of one hypothetical and one real.[2] To avoid income and substitution effects, we randomly drew which of the two real auction trials was to be binding and then drew individual binding products.[3]

The participants walked around the table and placed their bids on their bidding forms as they studied each alternative. The participants were not allowed to communicate with each other during the bidding process. To reduce any systematic ordering effects, the participants could start at any of the 12 alternatives on the table. The picture treatments were conducted in the same way but with 12 pictures, 3 pictures from each of the four categories of cosmetic appearance. In each session, half of the 12 pictures were labeled as organic and all the pictures were labeled as organic in half of the sessions and as conventional in the other half. This was done to reduce any unforeseen effects from small differences in the pictures and thereby to increase the internal validity of the study.

Experimental Subjects

The experiment was conducted in central Iowa in 2005. The participants were recruited by e-mail notice and advertisements in newsletters on campus. The e-mail recruitment of participants went to faculty and staff through solicitations to college-level and university units (e.g., departments, physical plant) in order to make the recruitment pool as broadly representative of the local area and state population as possible. We restricted the pool to limit participation of graduate students and did not solicit undergraduate students. The recruitment letter indicated that participants would be asked about their market decisions on fruit purchases, but nothing was said about appearance or organic production.

Seventy-four people participated in the experiment, 33% male and 67% female. The ages ranged from 20–70 years old, with 27% in the age 20–29 category, 30% age 30–39, 14% age 40–49, 20% age 50–59, and 9% age 60 and older. The age distribution in the sample differed from the age distribution in the state's population in that there were relatively more respondents between 20 and 39, and relatively fewer in the other age groups, especially people in their forties. In 2000, of the share of the state's population age 20–65, there were 47% in the 20–39 age range compared with the sample of 57% in this range. The subjects' average household income was $49,220 with a standard deviation of $30,520.[4] The median household income was $42,500. This compared with the state's median household income in 1999 of $40,442. Among the participants, 17% did not have a college diploma, 11% had a college diploma, 22% had some graduate school education, and 50% had a graduate degree. The recruited sample had higher average education levels than the state average. Here it should be noted that in a survey of consumer studies of organic products, Thomson (p. 1117) writes that "[t]he national evidence suggests positive correlation between education and organic purchase." Based on this relationship, we would expect to have a higher proportion willing to pay a premium for organic

[2] The motivation for this design is to control for any possible effects the hypothetical auction in the first round might have on the real auction in the second round. The estimation results show that the effect is negligible.

[3] The instructions are available from the authors upon request.

[4] Three of the observations had missing values on income, and these values were imputed using best-subset regression. The independent variables for the regression were education, age, gender, and association with the university (such as faculty, staff, student, etc.). The imputation was completed using STATA7.0.

products in our sample than in the general public.

In total, the 74 participants valued 14 types of apples (conventional apples with four appearance grades in both a hypothetical and a real auction, and organic apples with four appearance grades in a hypothetical and two appearance grades in a real auction). Therefore, the effective sample size for the WTP used in the estimations is 1,036.

Random Parameter Model

We use three sets of variables to explain the variation in WTP. First is the variation in the product quality attributes. Second is the variation in sociodemographics and consumers' attitudes. Third is the variation in the experiment. Based on this, we specify the following econometric model to explain the consumers' WTP for the apples:

$$(1) \qquad WTP_{ij} = \alpha x_j + \beta y_{ij} + \gamma z_j + \varepsilon_{ij}$$

where WTP_{ij} is individual i's bid for product j; and $x_j$is a vector containing the constant term, the product quality attributes *Organic* and *Spot,* and the experimental design variable *Picture* for product j. *Organic* is a binary variable that is equal to one if the product is organic, and zero otherwise; *Spot* is defined as a continuous variable measuring the percentage of spot coverage,[5] and *Picture* is a binary variable that is equal to one for the pictures and zero for the real apples. Other independent variables include y_{ij}, a vector of interaction effects between the sociodemographics and consumers' attitudes for individual i and the product quality attributes *Organic* and *Spot* for product j; and z_j, a vector of interaction effects between product quality attribute variables and between product attributes and design variables including *OrgSpot, OrgPicture,* and *SpotPicture* where *OrgSpot* measures the interaction effect between the two product attributes *Organic* and *Spot, OrgPicture* is the interaction between *Organic* and *Picture,* and *SpotPicture* is the interaction between *Spot* and *Picture*. The model we used is a panel version of the random parameter model, where the parameters in β and γ are fixed, and the parameters in α are random parameters assumed to follow a standard normal distribution with mean α_0 and standard deviations of $\sigma_{Constant}$, $\sigma_{Organic}$, σ_{Spot}, and $\sigma_{Picture}$. ε_{ij} is the error term, which is assumed to follow normal distribution with mean zero.

Results and Discussion

As mentioned previously, the 74 participants were divided into eight groups. The participants attended the auction experiments in one of the eight groups. Table 1 shows the descriptive statistics for the bids divided into two production methods (organic and conventional), four appearance levels (SpotA, SpotB, SpotC, and SpotD), and two elicitation methods (hypothetical and real auctions). The mean bids for organic and conventional apples with different levels of spots in hypothetical and real auctions are also shown in Figure 1. There are several things that we can see directly from Table 1 and Figure 1. First, on average, consumers are willing to pay more for organic apples than for conventional apples with the same appearance. *t*-tests show that participants' WTP for OrganicA and OrganicB apples are significantly higher than that for their conventional counterparts at a 5% significance level in the real auction.

Second, consumers on average are willing to pay more for apples with no or little cosmetic damage than for apples with more cosmetic damage. Participants' WTP for SpotA apples is significantly higher than their WTP for SpotB apples for both conventional and organic apples in the hypothetical auction ($\alpha = 0.10$ and $\alpha = 0.05$, respectively) and in the real auction ($\alpha = 0.01$ for both). Even though when using real products (actual apples) we had only SpotA and SpotB apples for the organic apples, the statistical *t*-tests used to test for the differences between WTP for SpotA and SpotB indicate that the blemished appearance of apples affected the participants' bidding decision in all

[5] The variable *Spot* is created as a continuous variable from the four graded levels and equals the average spot level in the spot categories, that is, *Spot* equals 0 for SpotA, 3 for SpotB, 5 for SpotC, and 9 for SpotD.

Table 1. Descriptive Statistics of the Bids

Production Method	Auction	Statistics	SpotA	SpotB	SpotC	SpotD
Conventional	Hypothetical	Mean	2.73	2.21	1.60	0.73
		S.D.	1.60	1.26	0.98	0.74
		Median	2.25	1.90	1.38	0.59
		% zero bids	1.89%	1.89%	5.67%	37.7%
Conventional	Real	Mean	1.83	1.15	0.99	0.57
		S.D.	0.88	0.74	0.77	0.59
		Median	1.74	1.18	0.87	0.49
		% zero bids	2.06%	13.4%	18.56%	38.14%
Organic	Hypothetical	Mean	3.22	2.60	1.89	0.96
		S.D.	1.69	1.42	1.18	1.05
		Median	2.70	2.15	1.75	0.75
		% zero bids	0	0	3.77%	33.96%
Organic	Real	Mean	2.08	1.58		
		S.D.	0.95	0.88		
		Median	1.93	1.45		
		% zero bids	0	1.03%		

cases—irrespective of production method. These results are validated by other estimation results presented later in the article.

Third, participants stated higher WTP on average for all alternatives in the hypothetical auctions than in the real auctions. *t*-tests show that participants' WTP for organic and conventional SpotA and SpotB apples in the hypothetical auctions are higher than their counterparts in real auctions ($\alpha = 0.01$). Fourth, there were almost no zero bids for the perfect apples, and none of the participants bid zero for all the apples. Thus the bidding shows the participants were willing to buy apples in the auction and that the zero bids for the spotted apples can be interpreted as zero WTP for these apples.[6]

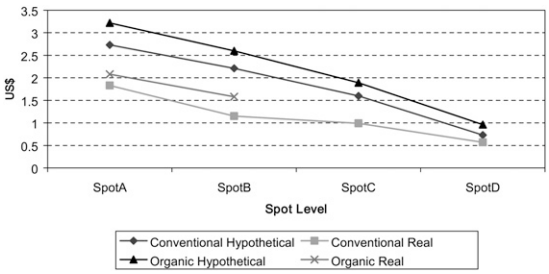

Figure 1. The Mean Bids for Organic and Conventional Apples with Different Level of Spots in Hypothetical and Real Auction

Fifth, and finally, the mean bids in the real auctions were below standard average national prices paid for fresh apples. This is consistent with rational bidders demanding the same payoff from the auctions as they would get from buying the apples that give them the highest net value in the market. USDA data show the average price of fresh apples was \$0.83 per pound in 1999 (Reed, Frazão, and Itskowitz), or \$0.96 per pound when adjusted to 2004 price levels. The Bureau of Labor Statistics (BLS) reports similar (though somewhat higher) values for red delicious apples. It is important to note, however, that the BLS data show the Midwest apple prices to be below the U.S. average prices; hence, we may expect some regional effect in the bidding (U.S. Department of Labor).

[6] Roosen et al. asked the participants to bid for an upgrade from one endowed bag of apples to other bags of apples. Thirty-five percent of the participants bid zero for all the alternatives. Their upgrade design did not allow them to distinguish between those participants who preferred the endowed bag and those who were indifferent between the bags. Bidding on all products allows us to measure both positive and negative price premiums.

We developed measures of consumer attitudes and preferences based on the survey questions. In addition to direct responses to questions, several consumer attitudes toward quality attributes were measured as composite constructs based on the participants' degree of agreement with selected statements. Because the participants answered several questions on the same quality attributes, we used principal component factor analysis to select and rank the questions included in the set of composite indicators and avoid the problem of multicollinearity (Greene, p. 58).

To measure consumers' sensitivity to price (*Price*), we asked the participants if they agreed or did not agree with four statements about the trade-off between quality and price using a 5-point Likert scale. For instance, one statement included in the index *Price* read, "I usually buy the lowest priced products." Consumers with a larger value of this index state they tend to be relatively sensitive to the price of products. Other composites included consumers' concern with the environment (*Envir*), consumers' tolerance of pesticides (*Pest*), and consumers' attitude toward appearance of apples (*Appear*). Consumers with a larger value of the index *Envir* were more concerned about the environment and held stronger beliefs about the idea that organic production can improve the environment. The measure of consumers' tolerance of pesticides (*Pest*) was based on two statements concerning the safety of and restriction on pesticide use. Consumers with a larger *Pest* index value were less tolerant of pesticides. The index on appearance of apples (*Appear*) was a construct based on consumers' concern about the importance of apple color, shape, texture, and size. Consumers with a larger value of *Appear* expressed more concern about the appearance of apples. Principal component factor analysis indicated these composite constructs were unidimensional (all had a Cronbach's alpha reliability of 0.6 or higher).

Other measures of consumer attitudes were based on single statements. They included attitudes toward food safety (*Safe*), taste (*Taste*), and nutrition (*Nutrition*) of apples. Consumers with a larger value of each of these indexes were more concerned about the respective attributes. It is important to note that all of these measures of consumer attitudes are based on stated preferences, whereas the real auctions elicit revealed preferences through the participants' behavior in a market where they face real trade-offs between money and goods. The definitions of all the variables used in the segmentation are shown in Table 2.

Figure 2 shows the inverse cumulative distribution of the difference in matched bids (i.e., the difference in bids from the same participants) between OrganicA and ConventionalA (OA-CA), and OrganicB and ConventionalA (OB-CA). OA-CA is calculated by subtracting the individual participant's mean bid for ConventionalA from the same participant's mean bid on OrganicA. Similarly, OB-CA is calculated by subtracting the individual participant's mean bid for ConventionalA from the same participant's mean bid on OrganicB.

From Figure 2, we can see that 19 (25%) of the participants bid higher for the ConventionalA apples than for the organic apples with the same appearance. This indicates that these consumers think that there is a negative value associated with organic production. Of the 55 (75%) participants bidding more for the OrganicA than the ConventionalA, 18 (24%) bid more than 50¢ more, eight (11%) bid more than $1 more, and two (3%) bid more than $2 more for the organic apples.

Comparing OrganicB with ConventionalA, we can see that of the 55 participants preferring the organic apples when they had the same appearance, now only 21 (28% of the total sample) still prefer the organic apples. This dramatic decline in the group preferring the organic apples indicates that appearance is very important for many consumers.

Table 3 includes information about the sociodemographic and attitude variables across the three consumer groups indicated by Figure 2. Group 1 (Conventional oriented group) prefers conventional to organic (Bid ConventionalA > Bid OrganicA), group 2 (Appearance oriented group) prefers organic but only if the appearance is as good as for the conventional (Bid OrganicA > Bid ConventionalA > Bid OrganicB), and group 3 (Organic oriented group) prefers the organic even when the appearance is lower than

Table 2. Definition and Summary Statistics of Variables

Variable	Definition	Mean	S.D.	Min	Max
Product attributes					
Organic	Organically (= 1) or conventionally (= 0) produced	0.46	0.50	0	1
Spot	Continuous measure of percentage coverage of spots	3.64	3.34	0	9
Picture	The products are shown in picture (= 1) or are real (= 0)	0.35	0.47	0	1
OrgSpot	Interaction effect of variable *Organic* and variable *Spot*				
Sociodemographics					
Age[a]	Age of the participants	40.30	13.18	25	65
Gender	Male = 0, Female = 1	0.67	0.47	0	1
Edu[b]	Education on a 6-point scale	4.96	1.27	2	6
Income[a]	Income in thousands of dollars	49.22	30.52	7.5	120
Attitudes					
Price[c]	Price sensitivity	0	1	−2.37	1.98
Envir[c]	Concern about environment	0	1	−2.29	1.89
Pest[c]	Pesticides risk tolerance	0	1	−2.41	2.33
Appear[c]	Attitude toward appearance of apples	0	1	−2.64	1.84
Taste[d]	Taste of apples	0	1	−2.93	0.52
Safe[d]	Food safety	0	1	−2.70	0.84
Nutrition[d]	Nutrition of apples	0	1	−2.03	1.25

[a] The age variable has seven categories and income variable has eight categories. The midpoint of the categories is used to form a continuous variable.

[b] 1 = some high school, 2 = high school diploma, 3 = some college or less, 4 = college diploma, 5 = some graduate school, and 6 = graduate degree.

[c] Factors from principal component analysis. These factors are derived from the statements listed in Table A1. The factors are standardized with mean zero and standard deviation of one. The standardized factors have minimum and maximum values shown in the last two columns of Table 2. The higher the values of the factors, the more participants are concerned (or sensitive) to the respective attribute.

[d] Based on the answer to the following question: How important are the following attributes of apples when you decide which apples to buy? (5-point scale where 1 is not important and 5 is very important)

that of the conventional (Bid OrganicB > Bid ConventionalA). We can see that the participants in group 1 (Conventional oriented group) tend to be younger than those in other groups and they are less concerned about the food safety related attributes such as environment, pesticides, food safety, and so on. Group 1 members also have the lowest income level and are most concerned about price; that is, they make up the group with the highest sensitivity to price. The consumers in group 2 (Appearance oriented group) care more about appearance than do those in other groups and are in the middle of the distribution with respect to concern about the environment and pesticide use. In contrast, those in group 3 (Organic oriented group) care most for the food safety related attributes and the taste, and they care least for the appearance and price. Those in group 3 (Organic oriented group) have the highest income and education levels, and they are the oldest compared with the other two groups.

To see if these groups differ significantly in all the sociodemographics and attitude variables, Multivariate Analysis of Variance (MANOVA) and the corresponding Wilk's Λ^* test are used (Johnson and Wichern).

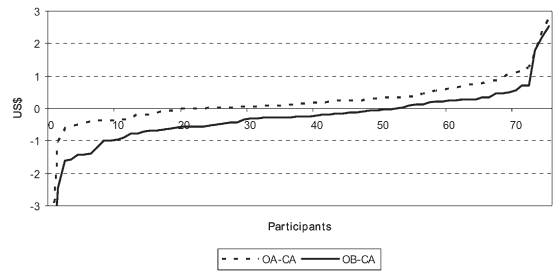

Figure 2. Inverse Cumulative Distribution of the Difference in Willingness to Pay between OrganicA, OrganicB, and ConventionalA

Table 3. Sociodemographics and Attitudes of the Groups

	Group 1 Conventional Oriented (19[a])		Group 2 Appearance Oriented (34[a])		Group 3 Organic Oriented (21[a])		ANOVA	MANOVA
	Mean	S.D.	Mean	S.D.	Mean	S.D.	*p*-value	*p*-value
Sociodemographics								
Age	36.05	15.23	38.23	12.24	43.10	12.49	0.21	
Gender	0.63	0.49	0.71	0.46	0.67	0.48	0.84	
Edu	4.84	1.30	5.00	1.15	5.10	1.44	0.82	
Income	36.97	22.75	41.14	31.06	58.69	32.85	0.05	0.51[b]
Attitudes[c]								
Price	0.59	1.19	−0.12	0.70	−0.34	1.08	0.01	
Envir	−0.52	1.01	0.02	1.01	0.46	0.79	0.01	
Pest	−0.22	1.12	−0.05	0.96	0.28	0.97	0.27	
Appear	−0.17	1.10	0.27	1.01	−0.31	−0.84	0.08	
Taste	−0.34	0.98	−0.01	0.94	0.37	1.06	0.08	
Safe	−0.16	0.98	0.10	1.03	0.32	0.98	0.22	
Nutrition	0.12	0.96	−0.18	1.07	0.02	0.94	0.35	0.04[d]
								0.20[e]

[a] Number of participants in each group.
[b] MANOVA of socio-demographic variables.
[c] The attitudes variables are standardized.
[d] MANOVA of attitude variables.
[e] MANOVA of both sociodemographic and attitude variables.

MANOVA is similar to ANOVA except it analyzes variances across groups by incorporating multiple variables instead of a single variable. ANOVA is employed to test whether the groups differ in each of the individual variables.

The *p* values of the ANOVA and MANOVA tests are listed in Table 3. The Wilk's Λ^* test statistic when including all the variables is 0.66, and the corresponding *p* value is 0.20. So the null hypothesis that the mean vectors are the same across the groups cannot be rejected at the 5% significance level. The *p* value of the Wilk's Λ^* test statistic obtained by including only the sociodemographic variables is 0.51, so the null hypothesis that the groups are the same in sociodemographic variables cannot be rejected at the 5% significance level. The ANOVA results show that at least one group differs from the other two in income ($\alpha = 0.05$). When including only the attitude variables, the *p* value of the Wilk's Λ^* test statistic is 0.04, so the null hypothesis that the groups are the same in their attitudes toward price, food safety-related quality attributes, appearance, taste, and nutrition is rejected ($\alpha = 0.05$). The three groups differ in attitudes. From the ANOVA results we conclude that the main source of differences among the three groups is through different attitudes toward price, environment, appearance, and taste, and by their income levels.[7]

The Random Parameter Model

We estimated the random parameter model as specified in Equation (1). The model includes the product attribute, experimental design variables, and the sociodemographic and attitude

[7] It is useful to compare our results with those of Roosen et al.; the two studies were done 10 years apart and both were conducted in similar areas. Although the two studies differ in many aspects, they address a similar valuation problem. In the Roosen et al. study, 38% of the participants had a high degree of concern about pesticide use, and of these, 76% preferred stricter pesticide regulations. In our study, 42% of the participants were (very) concerned about pesticide use; of these, 88% think stricter pesticide regulations should be set.

interaction effects with product attribute.[8] The model includes interaction effects of the sociodemographic and attitude variables with *Organic* and *Spot*, while the effects of the sociodemographic and attitude variables alone have been largely captured by the random parameters.[9]

Maximum likelihood was used to estimate the parameters in Equation (1). Although some variables have a naturally interpretable metric, others do not, especially the ordinal variables and interaction effects (McCall). Therefore, to simplify the interpretation of the parameters associated with the interaction effects between quality attitude variables with product attribute variables, these ordinally measured variables are standardized with a mean of zero and a standard deviation of one. The standardization is done by subtracting the respective variable's mean and dividing by its standard deviation.

The estimated parameters from the random parameter model are shown in Table 4. For the product quality attributes organic and spot and the effect of pictures, the results are consistent with the results presented in Table 1 and Figure 1.

From Table 4 we can see that the apple quality attributes (organic and spot) affect the participants' WTP for apples and the results are statistically significant. The constant, which can be interpreted as the average bid for 3 lbs of conventional real apples without any spots, is \$1.74.

The production method affects participant WTP significantly. Participants are willing to pay more for organic apples than for conventional apples: holding sociodemographic variables to be constant, the premium for real organic apples without any spots is about \$0.35 per 3 lbs [estimated at the mean value (= 0) of the variables that interact with organic, and *Picture*=0 and *Spot*=0]. However, the interaction between organic production and level of spots (*OrgSpot*) is statistically significant: the premium for organic production decreases by \$0.04 per 3-lb bag when the level of spot damage increases by 1%. Taking account of the combined direct and indirect effects, the participants' WTP decreases by \$0.14 per 3-lb bag when the level of spot damage for conventional apples increases by 1%. For organic apples, when the level of spot damage increases by 1%, the participant WTP decreases by \$0.18. The difference in the discount between the two production methods is statistically significant and indicates that cosmetic damage has a larger impact on the WTP for organic apples than for conventional apples.

Figure 3 summarizes the participants' predicted WTP for 3 lbs of organic apples and conventional apples with different levels of damage based on the estimated results and sample means for the explanatory variables. Note that participants' WTP for OrganicB apples is less than that for ConventionalA apples; participants' WTP for OrganicD apples is less than that for ConventionalC apples.

The results lead us to conclude that participants make a trade-off between production method and the blemish level of the apples. Even though, in general, participants are willing to pay more for organic apples, when there are "too many" blemishes on the organic apples, participants prefer to buy better-looking conventional apples. An extrapolation of the numbers shown in Figure 3 to apples with even more spots than the amounts on SpotD apples (9%) shows that participants would be unwilling to pay for such blemished apples regardless of the production method.

Based on the estimation results, we also compared the WTP for organic apples with different spot levels by participants with different levels of income (25th percentile or ~\$20,000 and 75th percentile or ~\$57,500) and different levels of concern about environment (25th percentile and 75th percentile). The results are shown in Figure 4.

[8] We estimated the correlation between the sociodemographic variables and preference attitude variables and found that the largest correlation was 0.17. We conclude that there is no multicollinearity problem in the model.

[9] We tried another model that included both the individual sociodemographic variables and attitude preference variables and the interaction effects. To test the model specification, a log likelihood ratio test was conducted. The test statistic was 6, which is less than the critical value 19.68, so the null hypothesis that the coefficients of the individual sociodemographic variables and attitudes preference variables are zero cannot be rejected at the 0.05 significance level.

Table 4. WTP for (Organic) Apples with Spots, Random Parameter Model

Variables	Coefficients	Standard Error
Product attributes		
Constant	1.740***,[a]	0.090
Organic	0.347***	0.076
Spot	−0.142***	0.013
OrgSpot	−0.040***	0.013
Sociodemographic interaction effects[b]		
AgeOrg	−0.048	0.074
GenderOrg	−0.057	0.059
EduOrg	−0.028	0.060
IncomeOrg	0.108*	0.070
AgeSpot	−0.008	0.015
GenderSpot	−0.020*	0.012
EduSpot	0.011	0.013
IncomeSpot	−0.004	0.015
Attitude interaction effects[b]		
PriceOrg	0.085	0.065
EnvirOrg	0.237***	0.088
TasteOrg	0.229***	0.083
SafeOrg	0.222***	0.085
PestOrg	−0.025	0.078
NutritionOrg	0.018	0.059
AppearOrg	0.003	0.056
NutritionSpot	0.005	0.012
PriceSpot	−0.009	0.014
EnvirSpot	0.002	0.018
TasteSpot	0.006	0.017
SafeSpot	0.006	0.018
PestSpot	−0.003	0.016
AppearSpot	−0.027**	0.012
Experimental design effects[b]		
Picture	1.035***	0.142
PictureOrg	0.151*	0.092
PictureSpot	−0.079***	0.015
Standard deviation of the random parameters		
$\sigma_{Constant}$	0.648***	0.066
$\sigma_{Organic}$	0.317***	0.055
σ_{Spot}	0.082***	0.010
$\sigma_{Picture}$	0.837***	0.094

[a] *, **, and *** denote significance at the 0.1, 0.05, and 0.01 levels, respectively.

[b] Interaction effects between two variables, as between *Edu* and *Organic*, is represented as *EduOrg*. Similar definitions hold for the attitude and experimental design variables. The interaction effects are standardized in the estimations, which makes interpretation of the main effect coefficients' straightforward because the interaction effects have zero means and unitary standard deviations (S.D.).

From Figure 4 we can see that the participants with higher income level (75th percentile) and more environmental concern (75th percentile) have the highest WTP for organic apples, while the participants with the lower income level (25th percentile) and less environmental concern (25th percentile) have the lowest WTP for organic. This is especially true when the surface blotches of the organic apples increase. Participants with higher income and more environmental concern are more tolerant of spots on organic apples than those with lower income and less environmental concern. This finding is based on the fact that the mean

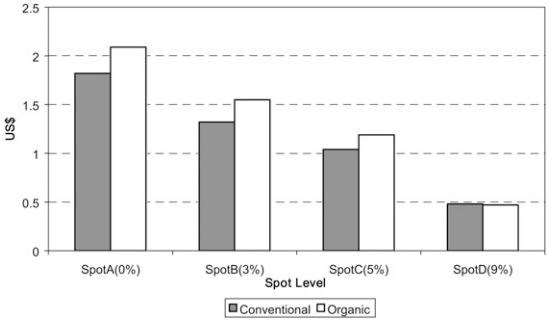

Figure 3. Estimated Consumer WTP for Apples with Different Levels of Spots

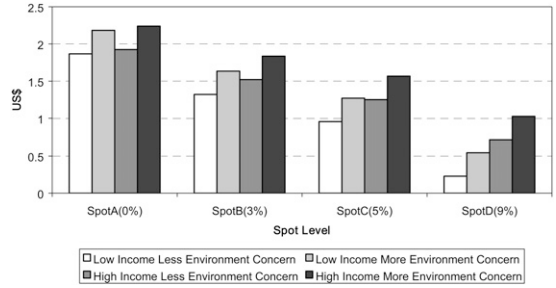

Figure 4. WTP for Organic Apples with Different Levels of Spots by Consumers with Different Levels of Income and Concern about the Environment

WTP for SpotC (SpotD) apples by participants with high income and more environmental concern is higher than the mean WTP for SpotB (SpotC) apples by participants with low income and less environmental concern.

Compared with income, the concern about the environment plays an important role in determining consumers' WTP for organic apples. For OrganicA, B, and C apples, the respective WTPs by the participants with lower income level and more environmental concerns are higher than the WTPs by the participants with higher income level and less environmental concerns. However, the differences between the WTPs decrease as surface blotches increase. And when the apple is too affected (SpotD), the WTP by the participants with low income level and greater environmental concern are lower than those by the participants with higher income level and less environmental concern. Thus, even for those with a high level of concern about the environment, consumers' tolerance of cosmetic damage on apples is limited.

As shown in Table 4, the interactions between the sociodemographic variables or attitude variables and the production method or the spot level include two statistically significant interaction effects. First, the results indicate that the interaction effect between income and organic production methods is positive and significant. Those who have higher income are willing to pay a higher price premium than those who have a lower income level. Second, the interaction effect between gender and spot damage is negative and significant at the 5% significance level; females are more reluctant to buy apples with spots. One possible explanation for this might be that females show more concern about the aesthetics of food than do men. Other socioeconomic interactions with the production method and spot level are not statistically significant.

Three of the interaction effects between organic production methods and attitude variables are significant. First, the interaction between concerns about the environment and organic production (*EnvirOrg*) is positive and significant. Those concerned about the environment are willing to pay a higher price premium for organic products compared with others. Positive interaction with environmental concerns suggests positive association between organic production methods and environmental interests in the minds of participants. Second, the interaction effect between concern about food safety and organic production (*SafeOrg*) is positive and significant. Those who are more concerned about food safety are willing to pay a higher premium for organic apples than those who are less concerned with food safety, a result that suggests that participants think organic products are safer than conventional products. Finally, the interaction effect between concern with taste and organic production (*TasteOrg*) is positive and significant. Those who are more concerned with taste are willing to pay a higher premium for an organic product. The p values for *EnvirOrg, SafeOrg,* and *TasteOrg* are less than 0.01.

In summary, WTP for organic products is enhanced by participants' being more concerned with the environment, more concerned

with the safety of food products, and their having high levels of interest in the "tastiness" of food products.

These results are consistent with previous studies showing that consumers associate organic production methods with a reduced health risk and may choose to reduce the risk from pesticide residues by switching to organically grown products (Williams and Hammitt; Magnusson and Cranfield). Recent survey evidence shows that consumers purchase organic foods because they perceive the foods to be fresh (68%), better for health, and a better source of nutrition (67%) (Whole Foods Market). Furthermore, 70% of the consumers said they bought organic food or beverages in order to avoid pesticides.

The interaction effects between spot level and attitude constructs are less strong. The interaction between concerns about appearance and spot damage (*AppearSpot*) is negative and statistically significant. Those who are more concerned with appearance place a higher discount on apples with increased levels of spot damage than do those who are less concerned with the appearance of apples.

In general, the relative valuations from the real and hypothetical auctions are consistent. However, the level of the valuations differs between the methods and therefore controlling for the experimental design was important. The variable *Picture* is highly significant, although two confounding factors should be noted: the use of the hypothetical auctions is perfectly confounded with the use of pictures, and in the pictures, the apples were presented out of the bags. The difference that we find between the two treatments can be a result of either of the above factors. Relative to the average bid of \$1.74 for a 3-lb bag of conventional apples without spots, participants bid about one dollar more for apples presented in pictures than for real apples.[10] In this respect, our results are in line with the large literature on hypothetical bias in valuation studies. The interaction effect between *Organic* and *Picture* (*PictureOrg*) is positive and significant and the interaction effect between *Spot* and *Picture* (*PictureSpot*) is negative and significant, results that indicate that the difference between the real and hypothetical auction is not fixed with the changes in WTP. These results are consistent with the values in Table 1 and Figure 1. The difference between the real and hypothetical auction seems to be proportional to WTP. If we divide the sum of the mean WTP for apples shown in a picture by the sum of the mean WTP for real apples, we find that the WTP in the hypothetical auction is 1.6 times that of the real auction.

The estimated means and standard deviations for all four random parameters are significantly different from zero. The mean value for the *Constant* is 1.74 and the standard deviation is $\hat{\sigma}_{Constant} = 0.65$. The latter indicates that there is significant difference among the consumers in their WTP for apples not captured by the variables in our model. The mean value for the *Organic* parameter is 0.35, and the standard deviation is $\hat{\sigma}_{Organic} = 0.32$. The large $\hat{\sigma}_{Organic}$ indicates that the preferences for organic attributes are not uniformly homogeneous among the participants, and that a portion of the consumers have a negative attitude toward the organic attribute. This is consistent with the picture we get from Figure 2. The mean value of the *Spot* parameter is -0.14 and the standard deviation is $\hat{\sigma}_{Spot} = 0.08$. The latter indicates that the consumers are heterogeneous with respect to how much they value the spots, but almost all are negative to the spots. The mean value for the *Picture* parameter is 1.01, and the standard deviation is $\hat{\sigma}_{Picture} = 0.84$. This indicates that there is significant variation in the effect of the picture treatments among the participants, and that the model predicts a negative individual *Picture* parameter for a portion of the participants. It should also be noted that the spread in the *Picture* parameter captures the effect of the three types of wording used before the hypothetical auctions.

[10] We ran another model using the bids only on pictures of apples and found the constant (the average bid for 3 lbs conventional perfect apples) was \$2.78, which is the same as the results from the random parameter model (1.74 + 1.04 = 2.78), and the premium for organic was \$0.46, which is almost identical to the results of the random parameter model (0.35 + 0.14 = 0.49) for 3 lbs of apples.

Conclusions and Implications

Consumers want environmentally friendly production methods, but they do not want the natural consequences of the environmentally friendly production: the blemished appearance of products. This result is of course very troublesome for organic producers. Organic producers are less able to avoid problems with cosmetic appearance, and they are hit harder in the retail market if they produce less-than-perfect apples. At first this result is somewhat surprising, given that previous studies have shown that the majority of consumers say they buy organic products to avoid pesticides. However, because consumers are willing to pay more for perfect organic apples than for perfect conventional apples, the percentage discount due to cosmetic damage has a higher dollar value in the discount of organic apples than for the conventional apples.

Our results on consumer attitudes, preferences, and valuations are based on responses from those who selected into the experiment. Given the state-specific population from which the participants were recruited, we would extrapolate our result with some caution. The participants are not representative of a broader population. However, the experimental design and approach have allowed us to explore further the nature of consumers' preference for organic fruit.

Of specific interest in this study is the premium that consumers are willing to pay for organic apples and the effect of different levels of cosmetic damage on the premium. We find that the premium for organic apples decreases as the level of spots on the organic apples increases, a result that supports earlier findings of Thompson and Kidwell and Roosen et al. Furthermore, our experimental design allows us to estimate interaction effects between production method and cosmetic damage. We find not only that the negative effect from cosmetic damage offsets the positive effect from organic production but also that cosmetic damage leads to discounting the premium for organic production. The premium the participants were willing to pay for organic apples decreased by $0.04 per 3-lb bag when the level of spot damage on both types of apples increased by 1%, and the reduction was statistically significant.

Consumers' tolerance of cosmetic damage on apples is limited. Even at relatively low levels of blemishes on the surface of organic apples, consumers preferred perfect-looking conventional apples. The consumers differ with respect to how they rank the importance of appearance. There is a relatively large segment of consumers in the organic market who are willing to accept a small level of cosmetic damage. However, if apple growers try to sell less-than-perfect organic apples at a price that is above the going price of conventional apples, few consumers will be willing to buy the organic apples.

This finding suggests the importance of quality attributes connected to cosmetic appearance, as is the case today with federal fruit grading systems (such as those regulated through the Agricultural Marketing Service of the U.S. Department of Agriculture) and that exist in many private contracts for fresh produce. To a large extent, fresh fruits in North American grocery stores have uniform appearance, while the fruits with imperfect appearance often are diverted to processed product markets such as for fruit juice and sauce. Our findings show that even when there is no strict federal grading system, fresh fruits with cosmetic damage have little potential in today's retail market because of consumers' limited tolerance for imperfect cosmetic attributes. When faced with limited consumer tolerance for cosmetic damage, apple producers must account for the trade-off between production technology and cosmetic damage in their production decisions in order to ensure their profits.

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APPENDIX

Table A1. Statements Related to the Attitudinal Variables

Attitudes	Definition	Statement
Price	Price sensitivity	Is price an important attribute when you consider which apple to buy? (1 = not important at all, 5 = very important) Are you concerned with the food price being too high? (1 = not concerned, 5 = very concerned)
		I select higher quality products even if they cost more. (1 = strongly disagree, 5 = strongly agree)
		I usually buy the lowest priced product. (1 = strongly disagree, 5 = strongly agree)
Envir	Concern about environment	Organic production is better for the environment than regular production. (1 = strongly disagree, 5 = strongly agree)
		Humans are severely abusing the environment. (1 = strongly disagree, 5 = strongly agree)
		Regular production is just as good for the environment as organic production. (1 = strongly disagree, 5 = strongly agree)
		I make a point of choosing products that do not damage the environment. (1 = strongly disagree, 5 = strongly agree)
Pest	Pesticide risk tolerance	Are you concerned with food grown using pesticides? (1 = not concerned, 5 = very concerned)
		Please give us your opinion about pesticide policies? (1 = Current pesticides are safe and consumer fears are unwarranted, 2 = Pesticides can be used safely, but there should be greater testing, 3 = Some currently used pesticides should be banned, and greater restrictions should be placed on remaining pesticides, 4 = All pesticides should be banned)
Appear	Attitude toward appearance of apples	How important is the texture of apples when you decide which apples to buy? (1 = not important and 5 = very important)
		How important is the shape of apples when you decide which apples to buy? (1 = not important and 5 = very important)
		How important is the size of apples when you decide which apples to buy? (1 = not important and 5 = very important)
		How important is the color of apples when you decide which apples to buy? (1 = not important and 5 = very important)
		How important is no skin damage of apples when you decide which apples to buy? (1 = not important and 5 = very important)
Taste	Taste of apples	How important is the taste of apples when you decide which apples to buy? (1 = not important and 5 = very important)
Safe	Food safety	How important is the food safety of apples when you decide which apples to buy? (1 = not important and 5 = very important)
Nutrition	Nutrition of apples	How important is the nutrition of apples when you decide which apples to buy? (1 = not important and 5 = very important)